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## **Environmental Principles and Concepts**

### **Introduction**

The Education and the Environment Initiative [Pavley, Chapter 665, Statutes of 2003 — AB1548] directs the California Environmental Protection Agency and the California Integrated Waste Management Board, in cooperation with the Resources Agency, State Department of Education, State Board of Education, and Secretary for Education to:

- develop education principles and concepts for the environment for elementary and secondary schools.
- ensure that the education principles and concepts for the environment are aligned to the academic content standards adopted by the State Board of Education and do not duplicate or conflict with any academic content standards.
- incorporate education principles for the environment in criteria developed for textbook adoption in Science, History/Social Sciences, Mathematics and English/Language Arts.

This draft is based on the contributions of over 100 scientists and technical experts, representing state agencies, universities, business and industry, and environmental organizations from across California.

The environmental principles examine the interactions and interdependence of human societies and natural systems. The nature of these interactions is summarized in the environmental principles and concepts that are presented below. The lists of examples will be further expanded, as necessary to fully encompass these principles and concepts.

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**Environmental Principles and Concepts**

The environmental principles examine the interactions and interdependence of human societies and natural systems. The nature of these interactions is summarized in the environmental principles and concepts that are presented below.

**Principle I**

The continuation and health of individual human lives and of human communities and societies depend on the health of the natural systems that provide essential goods and ecosystem services. As a basis for understanding this principle:

- Concept a.** Students need to know that the goods produced by natural systems are essential to human life and to the functioning of our economies and cultures.
- Concept b.** Students need to know that the ecosystem services provided by natural systems are essential to human life and to the functioning of our economies and cultures.
- Concept c.** Students need to know that the quality, quantity and reliability of the goods and ecosystem services provided by natural systems are directly affected by the health of those systems.

**Principle II**

The long-term functioning and health of terrestrial, freshwater, coastal and marine ecosystems are influenced by their relationships with human societies. As a basis for understanding this principle:

- Concept a.** Students need to know that direct and indirect changes to natural systems due to the growth of human populations and their consumption rates influence the geographic extent, composition, biological diversity, and viability of natural systems.
- Concept b.** Students need to know that methods used to extract, harvest, transport and consume natural resources influence the geographic extent, composition, biological diversity, and viability of natural systems.
- Concept c.** Students need to know that the expansion and operation of human communities influences the geographic extent, composition, biological diversity, and viability of natural systems.
- Concept d.** Students need to know that the legal, economic and political systems that govern the use and management of natural systems directly influence the geographic extent, composition, biological diversity, and viability of natural systems.

**Principle III**

Natural systems proceed through cycles that humans depend upon, benefit from and can alter. As a basis for understanding this principle:

- Concept a.** Students need to know that natural systems proceed through cycles and processes that are required for their functioning.
- Concept b.** Students need to know that human practices depend upon and benefit from the cycles and processes that operate within natural systems.
- Concept c.** Students need to know that human practices can alter the cycles and processes that operate within natural systems.

**Principle IV**

The exchange of matter between natural systems and human societies affects the long-term functioning of both. As a basis for understanding this principle:

- Concept a.** Students need to know that the effects of human activities on natural systems are directly related to the quantities of resources consumed and to the quantity and characteristics of the resulting byproducts.
- Concept b.** Students need to know that the byproducts of human activity are not readily prevented from entering natural systems and may be beneficial, neutral, or detrimental in their effect.
- Concept c.** Students need to know that the capacity of natural systems to adjust to human-caused alterations depends on the nature of the system as well as the scope, scale, and duration of the activity and the nature of its byproducts.

**Principle V**

Decisions affecting resources and natural systems are based on a wide range of considerations and decision-making processes. As a basis for understanding this principle:

- Concept a.** Students need to know the spectrum of what is considered in making decisions about resources and natural systems and how those factors influence decisions.
- Concept b.** Students need to know the process of making decisions about resources and natural systems, and how the assessment of social, economic, political, and environmental factors has changed over time.

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**Principle I**

The continuation and health of individual human lives and of human communities and societies depend on the health of the natural systems that provide essential goods and ecosystem services. As a basis for understanding this principle:

<b>Concept a.</b>	Students need to know that the goods produced by natural systems are essential to human life and to the functioning of our economies and cultures.	Examples related to the concept <sup>1</sup> : <ul style="list-style-type: none"><li>• Terrestrial systems — goods include food, energy, clean air, building products, and fiber, industrial products and their component parts, pharmaceuticals, genetic resources, and recreational resources.</li><li>• Freshwater systems — goods include water, food, energy, industrial products and their component parts, genetic resources, and recreational resources.</li><li>• Coastal and marine systems — goods include food, energy, industrial products and their component parts, genetic resources, and recreational resources.</li></ul>
<b>Concept b.</b>	Students need to know that the ecosystem services provided by natural systems are essential to human life and to the functioning of our economies and cultures.	Examples related to the concept: <ul style="list-style-type: none"><li>• Terrestrial systems — ecosystem services include: oxygen production upon which human respiration depends; protection from ultraviolet radiation by stratospheric ozone; the cycling and movement of nutrients; pollination of crops and natural vegetation; and, dispersal of seeds which influence food production.</li><li>• Freshwater systems — ecosystem services include: the productivity of spawning and nursery grounds upon which fisheries depend; the capacity of wetlands to detoxify waste, thereby influencing the health of humans and human communities; and, the cycling and movement of nutrients through waterways which enhance soil fertility and resultant agricultural productivity.</li><li>• Coastal and marine systems — ecosystem services include: oxygen production upon which human respiration depends; mitigation of loss and damage from flooding by absorption qualities of coastal wetlands; primary productivity and resultant support of fisheries; and, moderation of weather and climate that affect the health of humans and human communities.</li></ul>
<b>Concept c.</b>	Students need to know that the quality, quantity and reliability of the goods and ecosystem services provided by natural systems are directly affected by the health of those systems.	Examples related to the concept: <ul style="list-style-type: none"><li>• Terrestrial systems — soil nutrient levels affect agricultural productivity; habitat alteration or loss may result in reduced biological diversity and subsequent changes to ecosystem services and goods such as potential pharmaceutical agents; deforestation affects atmospheric conditions and climate that in turn affect the health of humans and human communities.</li><li>• Freshwater systems — contamination of streams and rivers affects drinking water supplies; alteration or loss of coastal wetlands may increase the likelihood of loss and damage by flooding.</li><li>• Coastal and marine systems — contamination as a result of energy production and transportation affects productivity of fisheries and wildlife; removal of keystone species by harvest or bycatch may affect the productivity of fisheries.</li></ul>

<sup>1</sup> Examples such as these will be used as the basis for developing a model curriculum that helps students master the academic content standards as they learn the environmental principles and concepts.

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**Principle II**

The long-term functioning and health of terrestrial, freshwater, coastal and marine ecosystems are influenced by their relationships with human societies. As a basis for understanding this principle:

**Concept a.** Students need to know that direct and indirect changes to natural systems due to the growth of human populations and their consumption rates influence the geographic extent, composition, biological diversity, and viability of natural systems.

Examples related to the concept<sup>1</sup>:

- Terrestrial systems — the growth of human populations can result in habitat conversion for human use; use or removal of plants, animals, soil, minerals, and land; introduction of invasive exotic organisms; unnatural fire regimes; and unsustainable demands placed on the goods and services these ecosystems provide.
- Freshwater systems — the growth of human populations can result in habitat conversion for human use; consumption of water supplies; secondary effects from alterations to terrestrial systems; use or removal of aquatic plants and animals; introduction of invasive exotic organisms; discharge via stormwater and wastewater; and unsustainable demands placed on the goods and services these ecosystems provide.
- Coastal and marine systems — the growth of human populations can result in coastal habitat conversion for human use; secondary effects from alterations to terrestrial and freshwater systems; use or removal of plants and animals; introduction of invasive exotic organisms; and unsustainable demands placed on the goods and ecosystem services these ecosystems provide.

**Concept b.** Students need to know that methods used to extract, harvest, transport and consume natural resources influence the geographic extent, composition, biological diversity, and viability of natural systems.

Examples related to the concept:

- Terrestrial systems — the process of extracting minerals can alter or affect the viability of habitat and its biological diversity; the transportation of goods and people can fragment habitat and influence the movement of wildlife; the production of energy can alter or affect the viability of habitat and contaminate soil, air, and waterways.
- Freshwater systems — the management of water resources can alter or affect the viability of habitat and its biological diversity; the management of fisheries and wildlife can affect the robustness of wild populations; the transportation of goods and people on waterways can affect water quality and the health of freshwater systems.
- Coastal and marine systems — the management of fisheries and wildlife can affect the robustness of wild populations; energy production and consumption can alter atmospheric conditions and climate, resulting in altered ocean habitats (e.g., bleached coral reefs) and changes to biological diversity.

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<p><b>Concept c.</b> Students need to know that the expansion and operation of human communities influences the geographic extent, composition, biological diversity, and viability of natural systems.</p>	<p>Examples related to the concept:</p> <ul style="list-style-type: none"><li>• Terrestrial systems — industrial, housing, and land development can alter or affect the viability of habitat and its biological diversity; transportation systems can alter or affect the viability of habitat and disrupt the movement of wildlife.</li><li>• Freshwater systems — the management of water resources can alter or affect the viability of habitat and its biological diversity.</li><li>• Coastal and marine systems — industrial, housing, and land development can alter or affect the viability of habitat and its biological diversity; ocean transportation systems can alter or affect the viability of habitat and disrupt wildlife.</li></ul>
<p><b>Concept d.</b> Students need to know that the legal, economic and political systems that govern the use and management of natural systems directly influence the geographic extent, composition, biological diversity, and viability of natural systems.</p>	<p>Examples related to the concept:</p> <ul style="list-style-type: none"><li>• Terrestrial systems — the laws, regulations, policies, and economic incentives that govern or influence industrial, housing and land development can have a direct effect on land use, and in turn, influence terrestrial systems; the laws, regulations, policies, and economic incentives that govern or influence land ownership and management, forestry and agricultural practices, and transportation can have a direct effect on land use, and in turn influence terrestrial systems; the laws, regulations, policies, and economic incentives that govern or influence the management of wildlife; watersheds, waste, and other byproducts can influence the composition and biological diversity of a terrestrial system.</li><li>• Freshwater systems — the laws, regulations, policies, and economic incentives that govern or influence water ownership and rights and the management of water resources can have a direct effect on the availability of water and the viability of freshwater systems; the laws, regulations, policies, and economic incentives that govern or influence the management of fisheries, wildlife, aquaculture, forestry, and agriculture can influence the composition and biological diversity of freshwater systems; the laws, regulations, policies and economic incentives that govern or influence the collection, storage and distribution of energy, minerals and products; and, the generation, treatment and discharge of point and nonpoint source pollution can directly influence freshwater systems.</li><li>• Coastal and marine systems — the laws, regulations, policies, and economic incentives that govern or influence coastal land ownership and rights can have a direct effect on land use and waterways, and in turn, influence coastal and marine systems; the laws, regulations, policies, and economic incentives that govern or influence fishing rights; fisheries and wildlife management; mariculture practices; mineral extraction; and energy production and transport can influence the composition and biological diversity of coastal and marine systems; the laws, regulations, policies, and economic incentives that govern or influence coastal and watershed management, and, the generation, treatment and discharge of waste and other byproducts can influence the composition and viability of coastal and marine systems.</li></ul>

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**Principle III**

Natural systems proceed through cycles that humans depend upon, benefit from and can alter. As a basis for understanding this principle:

**Concept a.** Students need to know that natural systems proceed through cycles and processes that are required for their functioning.

Examples related to the concept<sup>1</sup>:

- Terrestrial systems — biogeochemical cycles such as oxygen, carbon, nitrogen, and water; fire; succession; and, climate; and system processes such as photosynthesis, respiration, population dynamics, soil formation, erosion, and decomposition enable these systems to function.
- Freshwater systems — biogeochemical cycles such as oxygen, carbon, nitrogen, and water; succession; and, climate; and system processes such as photosynthesis, population dynamics, eutrophication, decomposition; and water movement (surface to groundwater, etc.) enable these systems to function.
- Coastal and marine systems — biogeochemical cycles such as oxygen, carbon, nitrogen, and water; succession; and, climate; and system processes such as photosynthesis, population dynamics, and decomposition enable these systems to function.

**Concept b.** Students need to know that human practices depend upon and benefit from the cycles and processes that operate within natural systems.

Examples related to the concept:

- Terrestrial systems — cycles and processes yield goods and ecosystem services used in industrial, housing and land development; forestry and agriculture; transportation; environmental management systems; and, collection, storage, distribution, use and reclamation of water, energy, minerals and industrial products.
- Freshwater systems — cycles and processes yield goods and ecosystem services used in industrial, housing and land development; forestry and agriculture; transportation; environmental management systems; collection, storage, distribution, use and reclamation of water, energy, minerals and industrial products; and, aquaculture.
- Coastal and marine systems — cycles and processes yield goods and ecosystem services used in fisheries and wildlife management; mariculture; mineral extraction; energy production and transport; watershed management; transportation; environmental management systems; and, coastal development.

**Concept c.** Students need to know that human practices can alter the cycles and processes that operate within natural systems.

Examples related to the concept:

- Terrestrial systems — land management practices can alter carbon, nitrogen, and phosphate cycles; water management practices can alter the water cycle.
- Freshwater systems — industry and transportation practices can alter climate patterns and the and water cycle; land management practices can alter nitrogen and phosphate cycles, and contribute to nutrient loading and sedimentation in lakes; water management practices can alter the water cycle and the recharge of groundwater.
- Coastal and marine systems — fishing practices can alter fish population dynamics; mariculture can alter nitrogen and phosphate cycles; energy production practices can result in changes in oxygen production.

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**Principle IV**

The exchange of matter between natural systems and human societies affects the long-term functioning of both. As a basis for understanding this principle:

<b>Concept a.</b>	Students need to know that the effects of human activities on natural systems are directly related to the quantities of resources consumed and to the quantity and characteristics of the resulting byproducts.	Examples related to the concept <sup>1</sup> : <ul style="list-style-type: none"><li>• Terrestrial systems — housing and land development requires the consumption of building material, can influence or reduce habitat and influence habitat quality, change biological diversity, and/or generate solid waste; transportation practices and road construction consumes road surfacing materials, minerals, and energy resources, and can reduce habitat, influence habitat quality and/or emit pollutants.</li><li>• Freshwater systems —land management practices can alter forested slopes, resulting in erosion, and alteration of stream habitats; disposal of liquid and solid waste can influence water quality and freshwater habitat; consumption of freshwater fish can result in changes to biological diversity; use of water to support human activities can alter freshwater habitats and result in the generation of wastewater.</li><li>• Coastal and marine systems — overconsumption of fish and wildlife can result in changes to biological diversity; transportation practices, including the consumption of crude oil, can alter marine environments and result in the contamination of waterways and changes to biological diversity.</li></ul>
<b>Concept b.</b>	Students need to know that the byproducts of human activity are not readily prevented from entering natural systems and may be beneficial, neutral, or detrimental in their effect.	Examples related to the concept: <ul style="list-style-type: none"><li>• Terrestrial systems — nutrients and waste material that move through soil and living organisms, and across other natural systems, can increase soil fertility or can contaminate and be biomagnified; emissions (e.g., ozone, particulate matter, NOx, SOx, and greenhouse gases) that move through the atmosphere can affect the health of terrestrial organisms and can affect the global climate.</li><li>• Freshwater systems — nutrients, hazardous waste, solid waste, and heat from stormwater, wastewater, urban runoff that move through water and living organisms, and other natural systems can alter freshwater systems; saltwater intrusion caused by groundwater overdraft can affect water quality; emissions (e.g., NOx and SOx) that move through the atmosphere can acidify rain and lower the pH in freshwater systems.</li><li>• Coastal and marine systems — nutrients, hazardous waste, solid waste, and heat from stormwater, wastewater, urban runoff that move through brackish water, saltwater, and living organisms, and across other natural systems can contaminate and be biomagnified, and may pose a direct danger to wildlife.</li></ul>
<b>Concept c.</b>	Students need to know that the capacity of natural systems to adjust to human-caused alterations depends on the nature of the system as well as the scope, scale, and duration of the activity and the nature of its byproducts.	Examples related to the concept: <ul style="list-style-type: none"><li>• Terrestrial systems — adjustments include recovery through succession of human-caused fire and behavioral adaptations of species to enable coexistence with humans (e.g., peregrine falcons in downtown Los Angeles).</li><li>• Freshwater systems — adjustments include removal of contaminants found in urban runoff through biodegradation and adsorption, and natural reestablishment of riparian habitats in urban areas.</li><li>• Coastal and marine systems — adjustments include biodegradation of oil and grease; recovery of populations from overfishing; and the reestablishment of reefs and kelp beds using artificial substrates.</li></ul>

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**Principle V**

Decisions affecting resources and natural systems are based on a wide range of considerations and decision-making processes. As a basis for understanding this principle:

<b>Concept a.</b> Students need to know the spectrum of what is considered in making decisions about resources and natural systems and how those factors influence decisions.	<p>Examples related to the concept<sup>1</sup>:</p> <ul style="list-style-type: none"><li>• Legal factors – laws, treaties, regulations, policies and incentives implemented by local, state, national, and international agencies have direct bearing on decisions that are made about: resources and natural systems; distribution of effects across society; personal, corporate, and societal responsibility; and, quality of life.</li><li>• Economic factors – land ownership, rights, and responsibilities influence decisions that are made about resources and natural systems; the outcome of financial cost/benefit analysis and risk analysis influences decisions that are made about: resources and natural systems; distribution of effects across society; personal, corporate, and societal responsibility; efficiency; and, quality of life.</li><li>• Environmental sustainability – consideration of biological and habitat integrity, and the outcome of environmental cost/benefit analysis and risk analysis influence decisions that are made about resources and natural systems.</li><li>• Public health – identifying and understanding the health effects of exposure to environmental hazards influence decisions that are made about: resources and natural systems; distribution of effects across society; personal, corporate, and societal responsibility; and, quality of life.</li><li>• Socio-cultural factors – differing views based on culture, education, and belief systems influence decisions that are made about: distribution of effects across society; personal, corporate, and societal responsibility; what goods are perceived to be essential and/or desirable; resources and natural systems; and, quality of life.</li><li>• Recognition of incomplete knowledge – acceptance of and prudent allowance for a limited, incomplete, or changing knowledge base regarding natural systems, their functions, and associated baseline data, short-term and long-term effects of changes to natural systems, limits of cost/benefit and other economic, environmental, and public health models, the resiliency of natural systems in response to change, and the predictability of the effect of change on natural systems and human society influences decisions that are made about resources and natural systems.</li></ul>
<b>Concept b.</b> Students need to know the process of making decisions about resources and natural systems, and how the assessment of social, economic, political, and environmental factors has changed over time.	<p>Examples related to the concept:</p> <ul style="list-style-type: none"><li>• Decisions are often based on the use of cost/benefit and other economic, environmental and public health models</li><li>• Decisions are often an outcome of participatory democracy</li><li>• Changes in the assessment of factors are illustrated in case studies, e.g., changes to gold mining practices due to concern over water quality; changes in use of asbestos due to environmental health concerns; changes to the status of endangered and threatened species based on establishment of the Endangered Species Act.</li></ul>

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